Annual Report

2010-11

The UWI Seismic Research Centre is the official source of information for earthquakes and volcanoes in the English-speaking Eastern Caribbean.
The Seismic Research Centre (SRC) has been providing Eastern Caribbean governments with expert advice on geologic events and associated hazards affecting these islands for over 50 years. It is the regional agency responsible for monitoring earthquakes and volcanoes and for carrying out fundamental research into these phenomena for the English-speaking islands of the Eastern Caribbean. The SRC operates the largest network of seismographs and other geophysical monitoring instruments in the Caribbean region. Earthquake and volcano monitoring involve continuous collection and analysis of data and development and maintenance of monitoring techniques and instruments. These activities are the primary focus, but staff may be deployed as needed to any of the contributing countries. The SRC is one of the specialised research institutions of The University of the West Indies and its work directly impacts vulnerable island communities throughout the Eastern Caribbean. In addition to the routine monitoring of 19 live volcanoes and a seismically active region, the SRC collaborates with local, regional and international agencies on research projects relevant to its core areas of operation (seismology, volcanology and education & outreach) to better understand the geologic processes at work in the region with a view to reducing risk. In recent years, the SRC has played a more active role in promoting geologic hazard awareness and it is also part of a regional effort to establish a tsunami warning system for the Caribbean and adjacent areas. In April 2008, the SRC assumed joint management of the Montserrat Volcano Observatory in an arrangement with the Institut de Physique du Globe de Paris (IPGP) of France.
Welcome to our year...

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Executive Summary

Seismic activity continues to be at an elevated level in the Paria Peninsula and a new area of elevated activity now obtains in the area of Antigua-Barbuda. The seismograph network recorded a minimum of 879 earthquakes in our area of responsibility with 81% of these being located, an increase of just over 10% when compared with the previous reporting period. There were 25 significant felt events for the period, the strongest of which were four magnitude 5.1 events for earthquakes located in the Trinidad and Tobago region, St. Kitts and the Virgin Islands. Apart from the ongoing eruption of the Soufriere Hills Volcano on Montserrat, volcanic activity in the Eastern Caribbean was relatively quiet with most of the volcanoes exhibiting low levels of activity.

In addition to routine monitoring operations academic year 2010-2011 was a busy one with respect to the successful submission and execution of related projects. Two projects of note were continuation of C.O.R.E. (Creating Opportunity from Research Experience) Programme and celebration of Earth Day. Both projects were funded from the SRC Departmental Consultancy Fund. The 2011 C.O.R.E. Programme gave two students an opportunity to undertake a GPS experiment in Trinidad and Tobago. Earth Day was celebrated for the first time in 2010 with an Earth Day Art & Illustration Competition for lower secondary school students in Trinidad & Tobago. The top twelve entries were used to produce a SRC 2011 Calendar.

During the year we were successful in bidding for various grants with colleagues within and outside the region. A strong focus of these projects was the continued improvement of our capacity to detect and quantify the effects of large magnitude earthquakes in the Caribbean. In this regard we learnt, during
2011 of the approval by the Board of the Caribbean Catastrophic Risk Insurance Facility (CCRIF) of a grant (US$120K), for the installation of an accelerometric network in the Caribbean. We were also informed that the government of Trinidad and Tobago had approved a grant (US$1.2M), to undertake seismic microzonation in Trinidad and Tobago. In addition to these initiatives, we continued work on a World Bank funded project (US$80K grant), executed by the Disaster Risk Reduction Centre (DRRC) at Mona, for the development of a methodology for the estimation of earthquake risk. We also launched a GEM Caribbean Regional Programme with assistance (€45K grant) from the Global Earthquake Model (GEM) Foundation.

As a result of our regional and international collaborations during the period in review we will, over the period 2011-2015 be engaged in the execution of three projects for which grant funds have been obtained from the European Commission.

These include: (1) TSUnami Alert REGional (TSUAREG) - a collaborative project (€352K grant) with the Institut de Physique du Globe de Paris (IPGP) through their observatories in Martinique and Guadeloupe for the installation of four VSAT stations in Antigua, Carriacou, Dominica and Saint Lucia; (2) REAKT (Real Time EArthquake RisK ReducTion) - a collaborative project (€50K grant) that will improve the efficiency of real time earthquake risk mitigation methods and its capability to protect structures, infrastructures and people and (3) VUELCO (Volcanic Unrest in Europe and Latin America: Phenomenology, eruption precursors, hazard foreCast, and risk mitigatiOn) - a collaborative project (€175K grant), with 10 other institutions drawn from the UK, Spain, Italy, Germany, France, Mexico, Ecuador that aims to improve our understanding of the processes behind volcanic unrest and the ability to forecast its outcome.

During the year we were successful in bidding for various grants with colleagues within and outside the region...
Seismograph networks
The seismograph network operated by the Seismic Research Centre in the Eastern Caribbean currently consists of over 52 instruments that comprise a mixture of short period and broadband seismometers and accelerometers. All seismic stations send their data to an ftp server from where they are automatically sent to the SRC Headquarters at St. Augustine, Trinidad. The system data can be processed locally in real time if deemed necessary.

Ground deformation networks
The SRC now operates a network of twelve continuous GPS stations (cGPS stations) in the Eastern Caribbean. These stations, located in Dominica (3 sites), Grenada, Antigua, St. Kitts, Nevis St. Vincent (2), Saint Lucia and Tobago were all fully operational throughout the period under review. They have been used along with other reference stations within the Caribbean Basin to investigate the tectonic velocity of this region. The network also aids in executing the campaign style GPS measurements used in our volcano monitoring networks. Data from the cGPS network is available online on request. Two campaigns to monitor ground deformation were conducted during the period; one on Nevis (11–17 October 2010) and another in northern Dominica (18-23 October 2010).
During the Nevis campaign a new continuously-operating GPS station was installed on the outskirts of the capital Charlestown. A new continuous GPS station (cGPS) was also installed in Saint Lucia and repairs were done to stations in Dominica. All stations were funded from the SRC Departmental Consultancy Fund.

**Geothermal monitoring**

The Seismic Research Centre initiated geothermal monitoring of hot springs and fumaroles associated with Lesser Antilles volcanoes in 2001. Routine sampling in islands including Dominica, Saint Lucia, Grenada, St. Vincent, St. Kitts, and Nevis have taken place on a regular basis. No field visits were conducted during the reporting period due to leave of absence of the principal staff member involved in the measurements.

**Seismic Activity 2010-2011**

During the period, the seismograph network (the ‘TRN network’) recorded a minimum of 879 earthquakes in the area of responsibility, of which a total of 709 events were located (81%), using our own data and the data contributions from Martinique, Guadeloupe, Puerto Rico and Venezuela. The locations represent an increase of just over 10% when compared with the previous reporting period. There were 25 events reported felt for the period.
The pattern of seismicity seen in the Eastern Caribbean has been changing in recent years from the distribution of previous decades. The low level of seismicity noted in the last report being observed in the Antigua-Barbuda area has been replaced by one of elevated activity. From January to the end of the reporting period 125 earthquakes were located in the area; the largest, of magnitude 5.1, was located west of Saba. Almost 60% of the events for the period were located north of 15ºN and serves to emphasise the level of the change in output in the Antigua-Barbuda area. The elevated output level around Dominica, apparent since the 2004 November 21 magnitude 6.0 and 2007 November 29 magnitude 7.3 earthquakes in the area, persists. The dense concentration of epicentres usually seen in the vicinity of the Paria Peninsula continues to be evident, with 167 of the 709 located events (more than 23%) occurring within our area of responsibility south of 11.5ºN and west of 61.7ºW. The largest on land Trinidad event was of magnitude 4.7 and was located near the north coast.
Volcanic Activity 2010-2011

Generally, the volcanic centres in the Eastern Caribbean have exhibited low levels of activity throughout the review period. In northern Dominica elevated seismic activity which began in June 2009 has diminished compared to that observed during the previous reporting period. In Montserrat, activity at Soufriere Hills volcano has remained low for the whole year and there has been no extrusion of lava. The volcano continues to emit sulphur dioxide at significant levels, but below the eruption average. Ground deformation studies indicate that an island-wide inflationary signal, radiating from the volcano is occurring, similar to previous pauses in activity over the 16 years of the eruption. Seismicity is also low, however short bursts of Volcano Tectonic earthquakes (up to 30) continued to occur occasionally over periods of approximately 30 minutes. On clear nights, spots of incandescence were visible on the lava dome. This indicates temperatures in fractures near the surface are still in excess of 500°C and all monitoring evidence taken together indicates that the eruption has not ended and that hot gases from depth are still able to escape freely to the surface.

Northern Dominica earthquakes occurring during the period 2010/8/01 – 2011/7/31. Cumulative count shows the total number of earthquakes recorded since 2009
Major Projects Initiated/Completed 2010-2011

1. The third C.O.R.E. (Creating Opportunity from Research Experience) Programme was held. The SRC introduced this summer internship programme for highly motivated university level students interested in pursuing geoscience careers. Students were provided with an opportunity to work closely with SRC staff on a current research project. This year students were involved in a project with one of our extra-regional collaborators collecting GPS data. (Funding: SRC DCF\(^1\) TT$20K)

2. Earth Day Art & Illustration Competition and 2011 Calendar. The SRC celebrated Earth Day for the first time in 2010 with an Art & Illustration competition for lower secondary school students in Trinidad & Tobago, to raise awareness on geo-hazards that affect the Caribbean.

\(^{1}\) Department Consultancy Fund
The top twelve entries were selected for publication in the Seismic Research Centre’s 2011 calendar which was officially launched in December 2010. (Funding: SRC DCF TT$32K)

3. Installation of new continuous GPS stations (cGPS) in Nevis and Saint Lucia and additional stations in Dominica. (Funding: SRC DCF US$15K)

New and Ongoing Projects

1. GEM Caribbean Regional Programme: Initiation of a Regional Programme for the Caribbean under the umbrella of the Global Earthquake Model (GEM) (see http://www.globalquakemodel.org/regional-programmes/caribbean for details). The Global Earthquake Model (GEM) is a global collaborative effort that brings together state-of-the-art science, national, regional and international organisations and individuals aimed at the establishment of uniform and open standards for calculating and communicating earthquake risk worldwide. (Funding: GEM Foundation €45K)

2. Installation of two radon monitoring stations in southwest Tobago: This study seeks to test the utility of changes in radon output as a seismic surveillance tool in the Eastern Caribbean. It has proved useful in other parts of the World. (Funding: SRC DCF and Campus Research and Publication Fund Committee US$25K)

3. GFDRR Disaster Vulnerability and Risk Assessment Modelling Jamaica and the Greater Caribbean Basin Project: This is a project managed by the Disaster Risk Reduction Centre (DRRC) and funded by the World Bank to produce a regional scale Risk Atlas for Flood, Hurricane and Earthquake and high resolution maps for similar hazards for four islands. (Funding: World Bank US$80K)

4. Montserrat Volcano Observatory (MVO) Management Contract: This is a management contract for the Montserrat Volcano Observatory for the period April 2008-March 2013. This project supports the full-time employment of five (5) members of staff, several support staff and other associated costs for running the Observatory. (Funding: Government of Montserrat EC$23M over 5 years)

5. TSUnami Alert REGional (TSUAREG): A collaborative project with and funded by the Institut de Physique du Globe de Paris (IPGP) through their observatories in Martinique and Guadeloupe for the installation of four VSAT stations in Antigua, Carriacou, Dominica and Saint Lucia. The objective is to enhance the regional seismograph network for tsunami detection and promote data sharing, which will feed into efforts to better understand the tectonics of the Eastern Caribbean. (Funding: European Commission €352K)

6. REAKT (Real Time Earthquake Risk Reduction): A collaborative three-year project with 23 countries, primarily in Europe. The general objective is to improve the efficiency of real time earthquake risk mitigation methods and its capability of protecting structures, infrastructures and people. The Eastern Caribbean will be a test region for the products developed. (Funding: European €50K)
The objective is to enhance the regional seismograph network for tsunami detection and promote data sharing...

7. **VUELCO (Volcanic Unrest in Europe and Latin America: Phenomenology, eruption precursors, hazard forecast, and risk mitigation):** A collaborative four-year project, with 10 other institutions drawn from the UK, Spain, Italy, Germany, France, Mexico, Ecuador. The broad aim is to significantly improve our understanding of the processes behind volcanic unrest and the ability to forecast its outcome aiding decision-making and management in an unrest situation. *(Funding: European Commission €175K)*

8. **Seismic Microzonation Studies in Trinidad and Tobago:** This project seeks to develop maps showing details of the different levels of a particular geotechnical hazard that may be triggered by an earthquake in areas of interest e.g. a city. Under the project, seismic microzonation studies will be conducted in strategic areas within Trinidad and Tobago and a programme will be established to enable the updating of such maps to promote the sustainability of this work. *(Funding: Government of the Republic of Trinidad and Tobago US$1.2M over 10 years)*

9. **A New Accelerometric Network to Evaluate and Mitigate Seismic Risk in the Eastern Caribbean and Jamaica:** This project seeks to establish a core network of strong motion instruments in the Eastern Caribbean and Jamaica as a crucial element of implementation of effective disaster risk reduction measures for earthquakes in the region. The key beneficiary will be the people living in the Caribbean since it will build the database necessary for guiding in the construction of earthquake resistant buildings. *(Funding: Caribbean Catastrophic Risk Insurance Facility US$120K).*

10. Installation of five (5) strong motion instruments in Trinidad and Tobago as part of a project **funded by the Trinidad and Tobago government** entitled “**Strong Ground Motion Studies in Trinidad and Tobago**”.

11. **Continuously Operating Caribbean GPS Observational Network (COCONET),** an NSF funded project executed by the UNAVCO consortium, intends to establish 50 new cGPS stations around the Caribbean Basin. SRC will contribute five existing cGPS stations in the Eastern Caribbean, host **four UNAVCO cGPS stations**, so expanding our network, and operate as a regional cGPS data products hub.
Outreach

The Education and Outreach (E&O) arm coordinates the CORE summer internship programme, develops information material, maintains the Centre’s Internet tools and routinely coordinates seminars and workshops on geo-hazards for the public including special interest groups, community groups and students/teachers.

Earth Science Week

The SRC commemorated Earth Science Week 2010 with an educational earth science poster display on Earthquake Energy in the Young Adult section of the National Library of Trinidad and Tobago. The SRC also delivered an educational workshop to students aged 13 to 14yrs on the science of earthquakes and fundamental earthquake safety information. This workshop and display aimed to encourage student interest in Earth Science research and to promote scientific understanding and awareness of earthquakes in the Eastern Caribbean.

Students display their earthquake-resistant structure during Earth Science Week 2010.
Tsunami Smart Workshop
A Tsunami Smart Teacher Training Workshop was conducted in collaboration with the Office of Disaster Preparedness and Management (ODPM) at the Rudranath Capildeo Learning Resource Centre, Couva, Trinidad. The Workshop was a follow up to the Tsunami and Other Coastal Hazards Warning Systems Project, Public Education and Awareness Component. The Workshop catered for secondary level Geography and Social Studies teachers from Trinidad and Tobago and launched the teacher education products developed under the project. The material was designed to raise awareness of tsunamis and other coastal hazards in the Caribbean and to enhance material already being used within the formal school system.

GEM Workshop
Members of the engineering and scientific communities together with representatives from international funding agencies and other regional stakeholders convened at the Kapok Hotel in Port of Spain Trinidad to launch the Global Earthquake Model (GEM) Caribbean Regional Programme which seeks to establish uniform and open standards for calculating and communicating earthquake risk worldwide. Participants were introduced to the GEM goals and discussions were held to establish a strategy for achieving them. Through this interaction, it is hoped that gaps in existing knowledge in the Caribbean regarding earthquake hazard, vulnerability and earthquake risk can be identified and the necessary research prioritized in order to make full use of the GEM software and tools in the Caribbean region. Minister of Science, Technology and Tertiary Education, Senator The Honourable Minister Fazal Karim, delivered the feature address at the opening ceremony during which he declared his support for the initiative given the Caribbean’s vulnerability to natural hazards such as earthquakes, which continue to undermine the region’s efforts to attain sustainable development.

CORE Summer Internship
This year’s CORE Internship project sought to re-measure a network of 18 campaign stations in Trinidad and Tobago so as to improve the precision of past measurements and better understand the nature of tectonics in the Trinidad and Tobago region. The interns assisted in the occupation of GPS sites and in the compilation and processing of the data.

SciTechnofest
The Centre participated in the NHERST SciTechnoFest, a biannual national science fair held over two weeks in Trinidad and Tobago. The Centre mounted a display on earthquakes, volcanoes and tsunamis and staff members were on hand to field questions and provide geo-hazard safety information to the public.

The SRC continues to struggle with

CORE Interns 2011, Michal Camejo and Avinath Ramadhin learn how to mount a GPS antenna
...active lobbying for and engagement of all stakeholders in pursuing the cause of a new building.

Projected Activities 2011-2012

the limitations of an old building which its current operations have long outgrown. As such the single most important activity for the Centre for the foreseeable future (until a building is constructed), is active lobbying for and engagement of all stakeholders in pursuing the cause of a new building. The Centre will continue to manage its monitoring operations, seek external funding and undertake research and other projects and continue to develop its outreach programmes as can best be done given current limitations. However, the focus for the SRC over the next biennium will be to secure the construction of a new building.

Some of the other specific projects which are either planned or already underway are summarised below.

• **Seismic Hazard Assessment for the Caribbean:** A collaborative two-year project to perform seismic hazard assessment for the Insular Caribbean including Belize, Hispaniola (Dominican Republic, Haiti), Suriname and the Guyanas. The project will be funded by the Caribbean Development Bank (CDB) and the Caribbean Regional Organization for Standards and Quality (CROSQ). It again involves collaboration with the Engineering Seismology team of EUCENTRE to produce a new generation of seismic hazard maps, which will address the challenges encountered in the first project. (US$230K)
• **Young Geoscientists Programme:** An expansion of the existing programme to encourage secondary and undergraduate level students to pursue geoscience careers. This includes further development of the CORE internship programme to allow for participation of students from outside of Trinidad & Tobago and an annual 2-day geoscience career workshop for 3rd and 6th Form students. (TT $90K)

• **Geoscience Video Documentaries:** Production of three 20-minute educational video documentaries; Earthquakes in the Caribbean, Volcanoes in the Caribbean, Careers in Geoscience. (TT$80K)

• **Neotectonics GPS and EDM experiment (Trinidad and Tobago):** This is a collaborative project with Prof. John Weber from Grand Valley State University (USA). It involves tectonic modelling and the installation of approximately six cGPS stations to monitor near-field deformation throughout the CRF zone. The objective of the project is to answer the question related to the seismic hazard of Trinidad, whether the Central Range Fault (12±3 mm/yr of strike-slip motion) is locked or creeping, or can possibly generate slow earthquakes. It is planned to submit the project under the GEM umbrella to the World Bank.

• **Construction of a new Home for the SRC:** The increasingly cramped environment and the need to lay in two fully appointed containers to increase office space, with the prospect of an additional one, prompted the suggestion to approach the construction of the new facility for the Seismic Research Centre on a phased basis. A plan for the first phase was received, revised and is being processed by St. Augustine Campus Projects Office. The most recent update suggests that Facilities Management is preparing documents for tender.

• **Revised web site for the SRC:** The current web site is now three years old and needs to be updated to be current with the needs of our stakeholders. (TT$60K).
Partnerships & Collaborations

Inter-Faculty
The University of the West Indies, Department of Civil and Environmental Engineering, St. Augustine
The University of the West Indies, Department of Geomatics Engineering & Land Management, St. Augustine

Academic Institutions
The University of Bristol, Department of Earth Sciences, United Kingdom
Universite Antilles Guyane, Guadeloupe
University of East Anglia, School of Environmental Sciences, United Kingdom
Incorporated Research Institutions for Seismology
UNAVCO Inc, Boulder, Colorado, USA
Department of Geology, University of South Florida
Department of Earth Science, University of Southern California
School of Applied Sciences, University of Northampton,

Monitoring & Disaster Management
Instituto Nazionale di Geofisica e Vulcanologia, Italy
Institut de Physique du Globe de Paris, France
Montserrat Volcano Observatory, Montserrat
Puerto Rico Seismic Network, University of Puerto Rico
Fundacion Venezolana de Investigaciones Sismologicas (FUNVISIS), Venezuela
Coastal Zone Unit, Barbados
Earthquake Unit, Mona Campus, UWI, Jamaica
CARICOM Regional Organisation for Standards and Quality
Caribbean Disaster Emergency Management Agency

Funding Agencies
World Bank
Caribbean Development Bank

Private Sector
Aspinall & Associates, United Kingdom
<table>
<thead>
<tr>
<th>Name</th>
<th>Post</th>
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<tbody>
<tr>
<td>Richard Robertson</td>
<td>Director</td>
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<tr>
<td>Joan Latchman</td>
<td>Seismologist</td>
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<tr>
<td>Walter Salazar</td>
<td>Earthquake Engineer</td>
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<td>Lloyd Lynch</td>
<td>Instrumentation Engineer</td>
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<td>Roderick Stewart</td>
<td>Volcano-Seismologist</td>
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<td>Eroussilla Joseph</td>
<td>Volcanologist</td>
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<td>Robert Watts</td>
<td>Volcanologist</td>
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<tr>
<td>Paul Cole</td>
<td>Director – MVO</td>
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<td>Adam Stinton</td>
<td>Volcanologist – MVO</td>
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<td>Thomas Christopher</td>
<td>Volcanologist – MVO</td>
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<td>Henry Odbert</td>
<td>Volcanologist – MVO</td>
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<tr>
<td>Caroline Murrell</td>
<td>Environmental Officer - MVO</td>
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<tr>
<td>Machel Higgins</td>
<td>Software Engineer</td>
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<tr>
<td>Chandradath Ramsingh</td>
<td>IT Officer II</td>
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<tr>
<td>Stacey Edwards</td>
<td>Education Officer</td>
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<tr>
<td>Deborah Robertson</td>
<td>Research Assistant – Volcanology</td>
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<tr>
<td>Monique Johnson</td>
<td>Research Assistant – Outreach</td>
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<tr>
<td>Clevon Ash</td>
<td>Research Assistant – Outreach</td>
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<tr>
<td>Ian Juman</td>
<td>Electronics Technician</td>
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<tr>
<td>Garth Mannette</td>
<td>Engineering Technician</td>
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<tr>
<td>Nisha Nath</td>
<td>Chief Research Technician</td>
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<tr>
<td>Amit Balchan</td>
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<tr>
<td>Farrah Madoo</td>
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<tr>
<td>Yvonne Joseph</td>
<td>Secretary</td>
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<tr>
<td>Carol Liverpool</td>
<td>Clerical Assistant</td>
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<tr>
<td>Shaun Bhodoo</td>
<td>Office Assistant</td>
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<tr>
<td>Susan Neverson</td>
<td>Part-Time Library Assistant</td>
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<tr>
<td>Nolan Ali</td>
<td>Senior Maintenance Assistant</td>
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<tr>
<td>Margaret Nero</td>
<td>Custodian</td>
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<tr>
<td>Joenel Alexander</td>
<td>Groundsman</td>
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<td>Lutchman Pollard</td>
<td>Research Technician</td>
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Staff Changes

ACADEMIC, SENIOR ADMINISTRATIVE AND PROFESSIONAL STAFF

Mr. Christian Eligon resigned from his post as Geophysicist, effective in October to take up a position abroad. Ms Liz Cole (Contract Officer II – Outreach) and Ms Caroline Murrell (Contract Officer II – Environmental) were both appointed for short periods to assist with the management of the Montserrat Volcano Observatory. Ms Alia Juman and Ms Jillian St. Bernard both joined the SRC as Research Assistants (Seismology) to assist with execution of the DRRC Risk Atlas Project.

<table>
<thead>
<tr>
<th>NAME</th>
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<tbody>
<tr>
<td>Cassandra LaBarrie</td>
<td>Research Assistant – Seismology</td>
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<tr>
<td>Omari Graham</td>
<td>Research Assistant – Seismology</td>
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<tr>
<td>Trevor Jackson</td>
<td>Emeritus Professor Igneous Petrology</td>
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<tr>
<td>Alia Juman</td>
<td>Research Assistant, Seismology</td>
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<tr>
<td>Jillian St. Bernard</td>
<td>Research Assistant, Seismology</td>
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<tr>
<td>Stephen George</td>
<td>Electronics Technician</td>
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<tr>
<td>Hannah Ramsingh</td>
<td>Seismic Technician</td>
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<tr>
<td>Myron Chin</td>
<td>GEM Operations Manager</td>
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<tr>
<td>Liz Cole</td>
<td>Outreach, MVO</td>
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ADMINISTRATIVE, TECHNICAL AND SERVICE STAFF

Mr. Stephen George joined the Electronics team as an Engineering Technician in March increasing the complement there to three.
Staff continue to publish in refereed journals, present at regional and international conferences and provide technical reports to stakeholders.

Publications

SRC authors in bold text

Refereed Journals


1 Includes one publication by staff who are longer at the Centre but the work listed here was undertaken during their time at the SRC


Technical Reports


Abstracts and Posters


Bernstein M, Calder ES Cole PD, Stinton AJ. (2011): The 8 January 2010 Vulcanian explosion at Soufrière Hills, Montserrat: Setting and Observations from Thermal and Video
Imaging. Soufrière Hills Volcano 15 Years on conference, MVO, Montserrat, W.I., 4-8 April 2011. Poster Presentation


